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The effect of smoothing chokes in reducing radiated acoustic noise from Thyristor-controlled television lamps

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ENGINEERING DIVISION

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This Report uses SI units in accordance with B.S. document PD 5686.

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SUMMARY

This report describes a series of measurements of acoustic noise radiated from lamps and fittings whose brightness is controlled by Thyristor dimmers.

Four different smoothing chokes were tested in conjunction with three lamp fittings under different dimmer load conditions, and their results are compared with those for unsmoothed waveforms. The investigation was the combined work of the Television Services unit of S.P.I.D. and the Acoustics Section of Research Department.

1. INTRODUCTION

It is proposed to install Thyristor-controlled dimmers as standard lighting control equipment in the new studios at Television Centre. The action of the Thyristor-controlled dimmer is to switch on the current to the lamps at a point in the supply waveform which may be varied to alter the mean current. In the absence of filters, the rise time is of the order of 2 μs and such a steep rise may well shock-excite mechanical components in the bulbs, thereby generating acoustic noise at frequencies greatly in excess of the supply frequency. The waveform may be smoothed to a certain extent, and the radiation of high-frequency acoustic noise thereby reduced, by the use of smoothing chokes.

Television Services unit of S.P.I.D. is concerned with the specification and selection of suitable smoothing chokes for use with Thyristor-controlled dimming circuits in order that both the inductive pick-up in microphone circuits and the acoustic noise radiated from lighting fittings shall be minimised. The techniques for measuring low levels of acoustic noise are somewhat specialised, and Acoustics Section of Research Department was therefore requested to assist S.P.I.D. in making these measurements, which were carried out in one of Research Department's sound measurement rooms.

2. MEASUREMENT PROCEDURE

The lamps were suspended in the sound measurement room from a shaft which could be rotated to find the direction in which the noise level at a microphone, 1 metre distant from the fitting, was a maximum. In an initial experiment, measurements of noise levels were made for various settings of the dimmer control and it appeared that the radiated noise level was a maximum when the lamp current was switched on at phase angles between 60°* and 120°. The results given in this report were all obtained with conduction angles of 90°.

Three types of television lamp fittings were used, viz. Scoop, Broad and cyclorama. These lamps were suspended as described above so that the microphone was in the most intense sound field, and the radiated acoustic noise levels were measured with dimmer loads of from 1 kW to 5 kW with each of the smoothing chokes in circuit in succession. The smoothing choke was then removed and the noise levels were measured with the unsmoothed waveform fed to the lamp.

Finally, the sound radiated by a bare bulb was measured for each of the four smoothing chokes and then with the unsmoothed waveform applied to the bulb.

* This indicates that the lamp is switched on at phase angles of 60° or 120° and is extinguished at 180° phase angle.

3. RESULTS

Figs. 1, 2 and 3 show the 'A' weighted noise levels produced by the three lamps plotted as a function of the total load on the dimmer for each of the four smoothing chokes, and also for the unsmoothed current waveform.

It will be noticed that, except for the condition of maximum load of the dimmers, the C.R.D. filter choke (curves *e*) gives the lowest acoustic noise level. In order to compare the noise levels radiated from the lamps with the background noise criterion for television studios, octave-band analyses were obtained and these are shown in Figs. 4 to 11.

Figs. 4 and 5 show the results obtained from a bare bulb and it will be seen that the noise level at a point 1 m from a bare bulb in the sound measurement room exceeds the permitted background level for television studios. This level may be expected to decrease in accordance with the inverse of the distance.

Figs. 6 to 11 inclusive give the octave-band levels produced by the fittings. The highest noise levels are produced on the axis of a Scoop and, since at frequencies above 100 Hz a Scoop will be an effective acoustic reflector, the noise levels on the axis will not be expected to decrease appreciably with distance from the fittings. The cyclorama fitting, which has a tubular bulb, produces the least acoustic noise.

4. CONCLUSIONS

The investigation has shown that the sound levels radiated from Thyristor-controlled television lighting fittings are unacceptably high at frequencies above 2 kHz. In particular, the noise levels radiated from Scoops at an axial point 1 metre from the bulb produced octave-band sound pressure levels 13 dB in excess of the maximum permissible level at 1 kHz and 23 dB in excess at 4 kHz.

Figs. 1 to 3 show that all four chokes tested produce significant reductions in the 'A' weighted noise figures for all three light fittings, the greatest reduction being obtained with the Scoop. It will be noticed that the C.R.D. filter choke, which is a type now out of production, produces the greatest reduction in 'A' weighted noise readings with all three lamp holders, although in the case of Scoops, the noise still considerably exceeds the criterion at some frequencies.

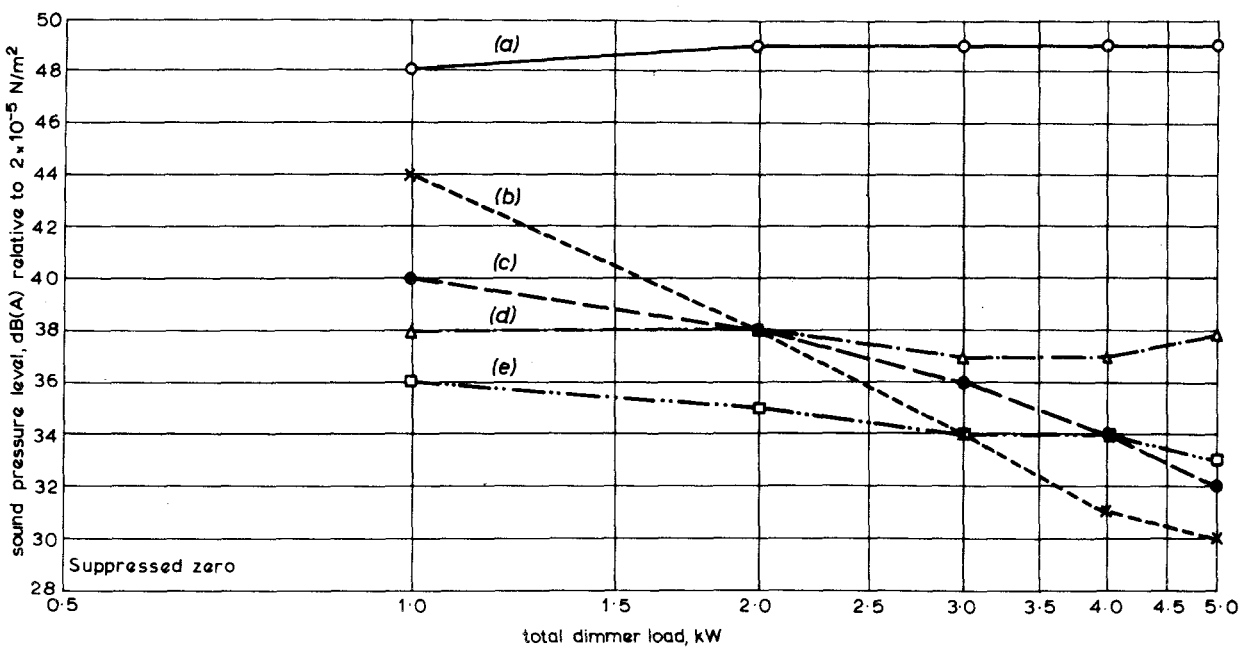

Fig. 1 - "A weighted" noise levels radiated by a 1 kW Scoop with different total loads on dimmer
(*a*) Unfiltered (*b*) 'C core' filter (*c*) 689 filter (*d*) 576 filter (*e*) CRD filter

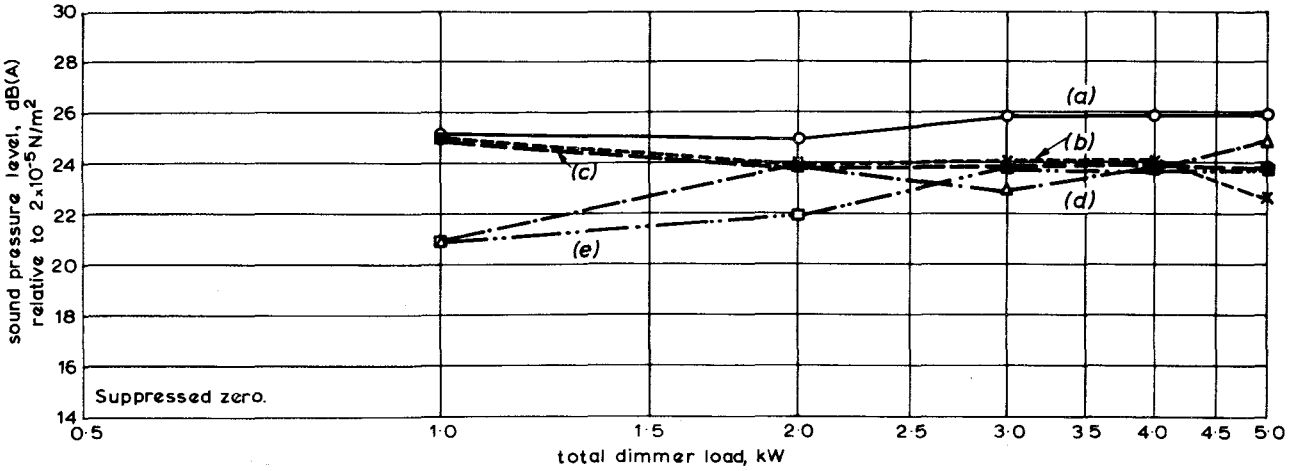

Fig. 2 - "A weighted" noise levels radiated by a 1 kW cyclorama with different total loads on dimmer
(*a*) Unfiltered (*b*) 'C core' filter (*c*) 689 filter (*d*) 576 filter (*e*) CRD filter

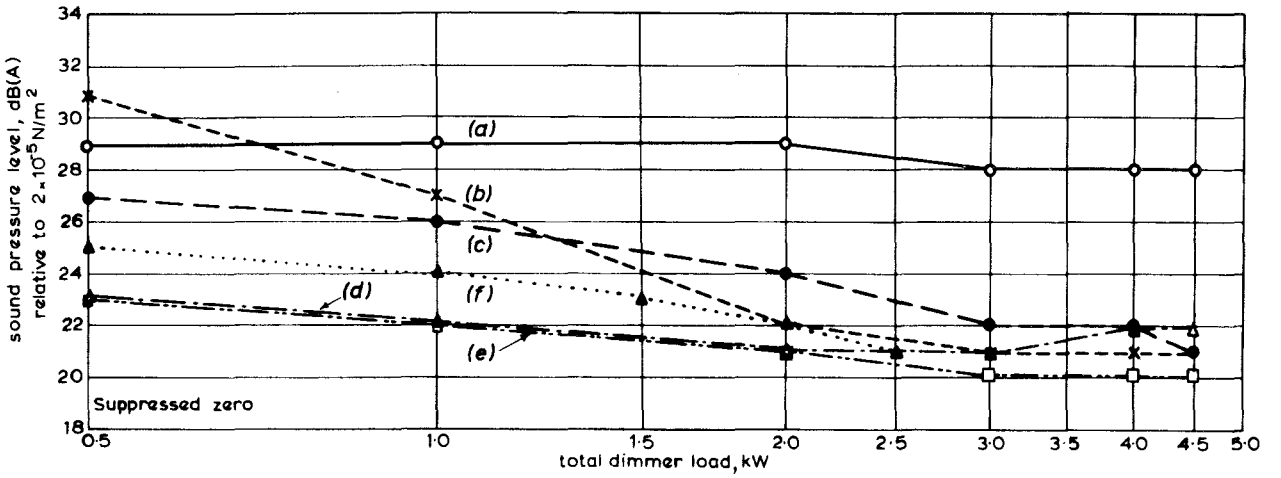

Fig. 3 - "A weighted" noise levels radiated by a 500 W Broad with different total loads on dimmer
(*a*) Unfiltered (*b*) 'C core' filter (*c*) 689 filter (*d*) 576 filter (*e*) CRD filter (*f*) J.T.M. module

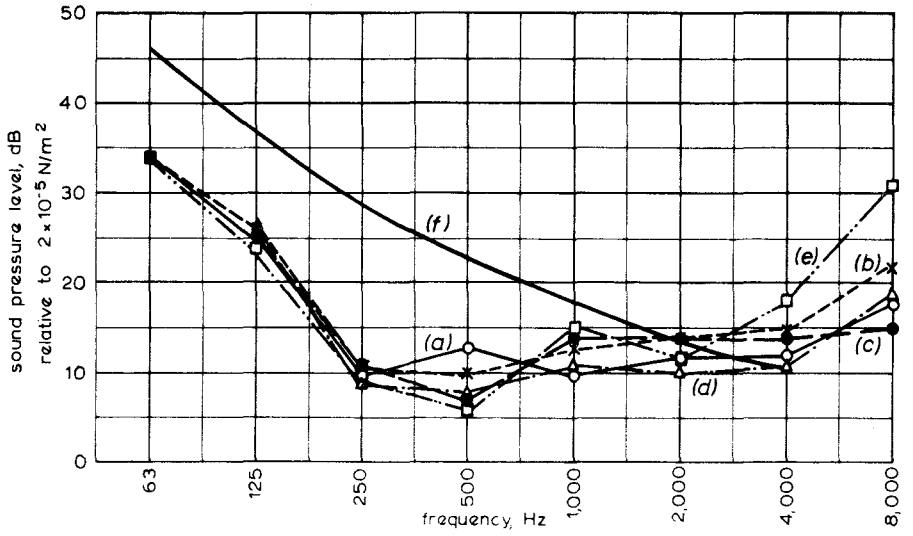

Fig. 4 - Sound levels at a distance of 1 m from a bare bulb, 1 kW total load on dimmer
(*a*) 576 filter (*b*) 'C core' filter (*c*) 689 filter (*d*) CRD filter (*e*) Unfiltered (*f*) Criterion

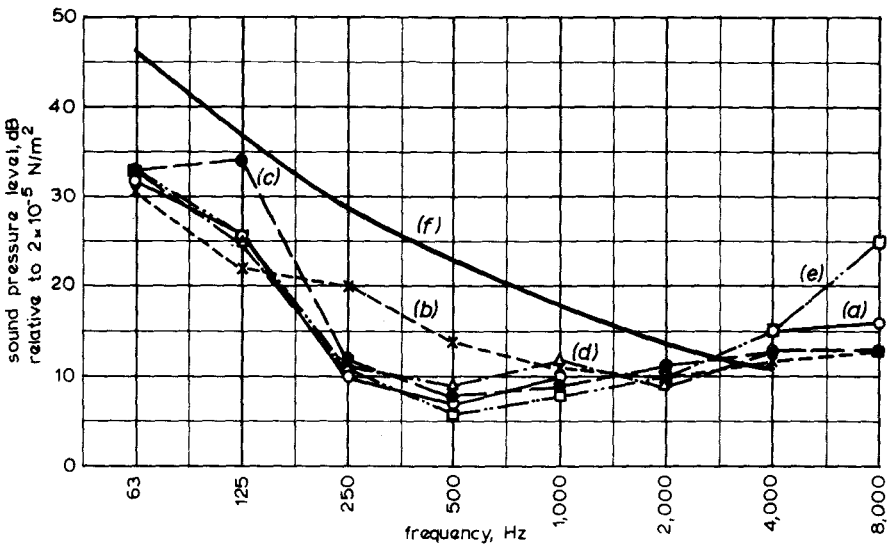

Fig. 9 - Sound levels at a distance of 1 m from a Broad, 4 kW total load on dimmer
(*a*) 576 filter (*b*) 'C core' filter (*c*) 689 filter (*d*) CRD filter (*e*) Unfiltered (*f*) Criterion

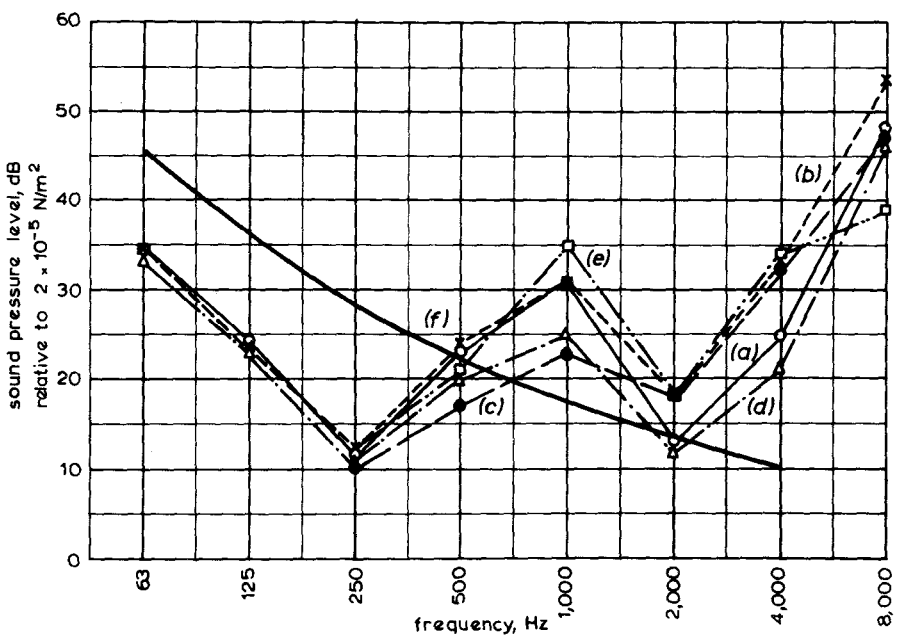

Fig. 10 - Sound levels at a distance of 1 m from a Scoop, 1 kW total load on dimmer
(*a*) 576 filter (*b*) 'C core' filter (*c*) 689 filter (*d*) CRD filter (*e*) Unfiltered (*f*) Criterion

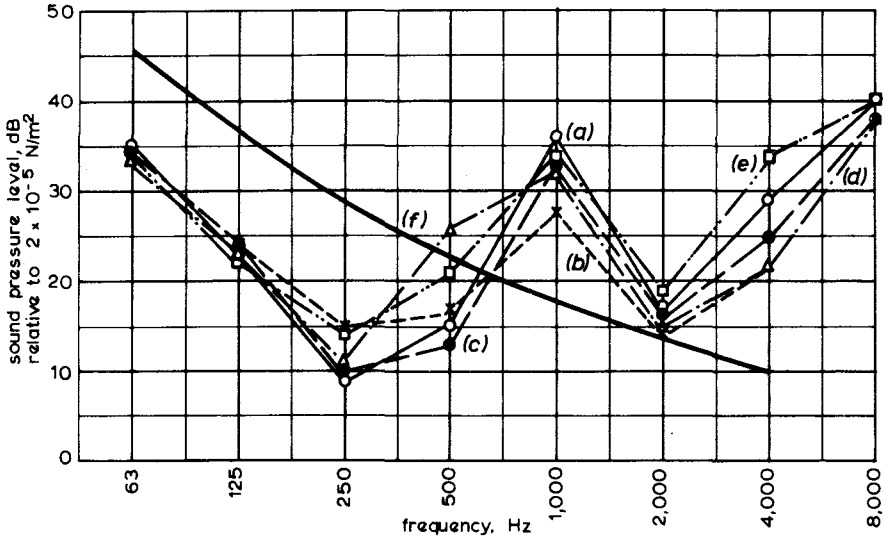

Fig. 11 - Sound levels at a distance of 1 m from a Scoop, 4 kW total load on dimmer
(*a*) 576 filter (*b*) 'C core' filter (*c*) 689 filter (*d*) CRD filter (*e*) Unfiltered (*f*) Criterion

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